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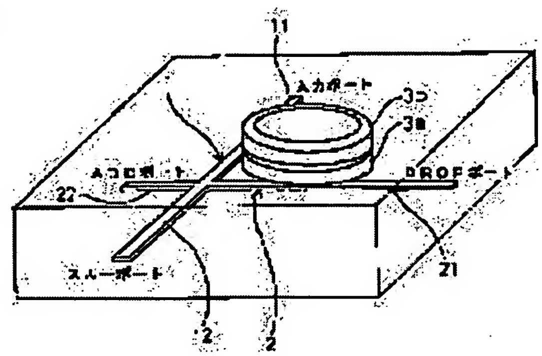
(54) OPTICAL WAVEGUIDE TYPE WAVELENGTH FILTER

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a small-sized and new optical waveguide type wavelength filter having an excellent boxy filter characteristic, and a 1×N optical waveguide type wavelength filter successively providing these optical waveguide type wavelength filters and a variable wavelength filter/optical switch constituted of those optical waveguide type wavelength filters.
SOLUTION: In the optical waveguide type wavelength filter laminated with a crossing input side optical waveguide 1 and an output side optical waveguide 2 and a ring resonator 3, and for performing ADD/DROP operation of the input side optical waveguide 1 and the output side optical waveguide 2 each other through the ring resonator 3, plural ring resonators 3a, 3b each other are laminated.



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CLAIMS

[Claim(s)]
[Claim 1] The optical waveguide mold wavelength filter which the laminating of the crossing input-side optical waveguide and output side optical waveguide, and the ring resonator is carried out, and is characterized by carrying out the laminating of two or more ring resonators in the optical waveguide mold wavelength filter which performs input-side optical waveguide, and ADD / DROP actuation between output side optical waveguides through this ring resonator.
[Claim 2] The optical waveguide mold wavelength filter of claim 1 with which the surface smoothness of a transparency band is adjusted according to spacing of ring resonators.
[Claim 3] The 1xN optical waveguide mold wavelength filter characterized by in while the optical waveguide mold wavelength filter of two or more claims 1 or 2 adjoining connecting the through bus of the input-side optical waveguide of an optical waveguide mold wavelength filter, and the input bus of the input-side optical waveguide of the optical waveguide mold wavelength filter of another side, being connected, changing, and the resonant wavelength of the laminating ring resonator of each optical waveguide mold wavelength filter differing mutually.
[Claim 4] For the optical waveguide mold wavelength filter of an endmost part location, the input bus of the input-side optical waveguide of the optical waveguide mold wavelength filter contiguous to the DROP bus of the output side optical waveguide is connected, it is connected [filter / adjoining / optical waveguide mold wavelength], and the resonant wavelength of the laminating ring resonator of the optical waveguide mold wavelength filter of an endmost part location and an adjoining optical waveguide mold wavelength filter is the same or a different 1xN optical waveguide mold wavelength filter of claim 3 mutually.
[Claim 5] The optical waveguide mold wavelength filter of claims 1 or 2 with which it becomes an ingredient with the ingredient in which the core layer of each optical waveguide, a cladding layer, or its both have an ingredient with the electro-optical effect, or a thermooptic effect, or a photoelastic effect, and the resonant wavelength of a laminating ring resonator serves as adjustable according to control of external electric field, control of temperature, or control of external force, or the 1xN optical waveguide mold wavelength filter of claims 3 or 4.
[Claim 6] The adjustable wavelength filter or the optical switch characterized by to be constituted by the optical waveguide mold wavelength filter of claims 1 or 2, or the 1xN optical waveguide mold wavelength filter of claims 3 or 4, to become with an ingredient with the ingredient in which the core layer of each optical waveguide, a cladding layer, or its both have an ingredient with the electro-optical effect, or a thermooptic effect, or a photoelastic effect, and for the resonant wavelength of a laminating ring resonator to serve as adjustable according to control of external electric field, control of temperature, or control of external force.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] Invention of this application relates to an optical waveguide mold wavelength filter. Invention of this application relates to the adjustable wavelength filter and optical switch constituted with the new optical waveguide mold wavelength filter which has the outstanding cube type filter shape, the 1this optical waveguide mold wavelength filter was connected [one] xN optical waveguide mold wavelength filter, and these optical waveguide mold wavelength filter in more detail.
[0002]
[Description of the Prior Art] The artificer of invention of this application has already proposed the optical waveguide mold wavelength filter useful as ADD / a DROP mold filter for wavelength access networks which performs input-side optical waveguide and ADD/DROP actuation between output side optical waveguides using a ring resonator with remarkable progress of high advancement in information technology in recent years that the further large-capacity-izing of optical communication and advanced features should be realized (application for patent No. 32480 [2000 to]).
[0003] Drawing 12 shows an example of this optical waveguide mold wavelength filter. As illustrated to drawing 12 , input-side optical waveguide (1) and output side optical waveguide (2) cross, and the laminating of the ring resonator (3) is carried out in near [the] an intersection. The laminating of this ring resonator (3) is carried out so that that part may have a certain spacing in the input bus (11) of input-side optical waveguide (1), and the DROP bus (21) of output side optical waveguide (2) and may lap with them. Moreover, the spacing is a ring resonator (3) and spacing in which the optical coupling of each optical waveguide (1) and (2) is possible. In this case, only a ring resonator (3) and the resonating wavelength light are separated spectrally into the DROP bus (21) of output side optical waveguide (2) through a ring resonator (3) among the wavelength multiplexing light which carries out the light guide of the input bus (11) of input-side optical waveguide (1).
[0004] With this optical waveguide mold wavelength filter, radius the order of about 10 micrometers is possible for a ring resonator (3), about 20nm order is possible for free spectral band width (FSR), and it serves as small and an outstanding filter shape.
[0005] However, the further improvement in a filter shape is desired so that the optical waveguide mold wavelength filter which was excellent in this way may also advance high performance-ization further. Since a filter shape was the Lorentz mold, more specifically, the surface smoothness of a transparency band was not obtained enough.
[0006]
[Means for Solving the Problem] Then, invention of this application is made in view of the situation as above, improves the conventional optical waveguide mold wavelength filter, and offers a new optical waveguide mold wavelength filter as [following] flattening of a transparency band realized the filter shape of a cube type.
[0007] Namely, the laminating of the input-side optical waveguide and the output side optical waveguide, and the ring resonator with which invention of this application crossed is carried out. In the optical waveguide mold wavelength filter which performs input-side optical waveguide, and ADD / DROP actuation between output side optical waveguides through this ring resonator The

optical waveguide mold wavelength filter (claim 1) characterized by carrying out the laminating of two or more ring resonators is offered, and it is making to adjust the surface smoothness of a transparency band according to spacing of ring resonators (claim 2) into that one mode in this optical waveguide mold wavelength filter.

[0008] Moreover, two or more above-mentioned optical waveguide mold wavelength filters adjoin [while], and, as for invention of this application, the through bus of the input-side optical waveguide of an optical waveguide mold wavelength filter and the input bus of the input-side optical waveguide of the optical waveguide mold wavelength filter of another side are connected. It is connected, change, also offer the 1xN optical waveguide mold wavelength filter (claim 3) characterized by the resonant wavelength of the laminating ring resonator of each optical waveguide mold wavelength filter differing mutually, and it sets in this 1xN optical waveguide mold wavelength filter. The input bus of the input-side optical waveguide of the optical waveguide mold wavelength filter with which the optical waveguide mold wavelength filter of an endmost part location adjoins the DROP bus of the output side optical waveguide is connected. It is connected [filter / adjoining / optical waveguide mold wavelength], and the resonant wavelength of the laminating ring resonator of the optical waveguide mold wavelength filter of an endmost part location and an adjoining optical waveguide mold wavelength filter makes it the one mode the same or to differ (claim 4) mutually.

[0009] In the above-mentioned optical waveguide mold wavelength filter or a 1xN optical waveguide mold wavelength filter, it also offers as the mode that become with an ingredient with the ingredient in which the core layer of each optical waveguide, a cladding layer, or its both have an ingredient with the electro-optical effect, or a thermooptic effect, or a photoelastic effect, and the resonant wavelength of a laminating ring resonator serves as adjustable according to control of external electric field, control of temperature, or control of external force (claim 5).

[0010] Invention of this application is constituted by the above-mentioned optical waveguide mold wavelength filter or the 1xN optical waveguide mold wavelength filter further again. It is what becomes with an ingredient with the ingredient in which the core layer of each optical waveguide, a cladding layer, or its both have an ingredient with the electro-optical effect, or a thermooptic effect, or a photoelastic effect. The adjustable wavelength filter or optical switch (claim 6) characterized by the resonant wavelength of a laminating ring resonator serving as adjustable according to control of external electric field, control of temperature, or control of external force is also offered.

[0011]

[Embodiment of the Invention] Along with the attached drawing, an example is shown hereafter, and the gestalt of implementation of invention of this application is explained in more detail.

[0012]

[Example] [Example 1] drawing 1 illustrates the optical waveguide mold wavelength filter which is one example of this invention.

[0013] For example, as illustrated to this drawing 1 , with the optical waveguide mold wavelength filter of this invention, the ring resonator (3) itself by which the laminating was carried out to the crossing input-side optical waveguide (1) and output side optical waveguide (2) is characterized by carrying out two or more laminatings further.

[0014] In this case, if it explains further, in drawing 1 , the laminating of the two ring resonators (3a) (3b) is carried out. If a lightwave signal combines with each ring resonator (3a) (3b), the even symmetric mode of propagation constant betae and the odd symmetric mode of propagation constant betao will be excited. Here, if spacing of two ring resonators (3a) (3b) is adjusted, the propagation constant difference of ** and an odd symmetric mode will become small, and each resonant wavelength will shift slightly. For this reason, the filter shape of the Lorentz mold which was illustrated to drawing 2 (a) is compounded, and as illustrated to drawing 2 (b), the filter shape of a cube type comes to be obtained.

[0015] Here, spacing of a ring resonator (3a) (3b) was changed, and the propagation constant was analyzed. As shown in drawing 3 , both the lower layer ring resonator (3a) and the upper ring resonator (3b) shall have the same structure etc., for example, set it to width-of-face Wr =1.50micrometer of the ring-core section, thickness tr =1.50micrometer of the ring-core section, the radius of R= 10 micrometers of a ring, and core refractive-index nc =1.7852.

[0016] Shape factor [on this condition and as opposed to the finesse (Finess) at the time of ring spacing trsep=1.00micrometer, 1.25 micrometers and 1.50 micrometers] (ShapeFactor) It analyzed. It asked for finesse as FSR to 3dB bandwidth of even symmetric mode, and asked for the shape factor with 1dB bandwidth to 10dB bandwidth. Moreover, input light is taken as TE-mode light with a wavelength of 1.543 micrometers. It is assumed that FSR is fixed. Drawing 4 illustrates this analysis result and shows the finesse and the ring spacing dependency of a shape factor. Although a shape factor is improved and the filter shape of a cube type is approached also in which ring spacing trsep so that finesse becomes large so that clearly from this drawing 4 , if a certain limit is exceeded, a filter shape will dissociate, and it understands that it is no longer the filter shape of a cube type.
[0017] The above result shows that the optimal ring spacing trsep is determined uniquely, in order to obtain the filter shape of a cube type most in a certain finesse. Therefore, the optical waveguide mold wavelength filter of this invention carries out the laminating of the two ring resonators (3a) (b), it is adjusting that spacing and the cube type filter shape excellent in the surface smoothness of a transparency band can be realized. By implementation of this cube type filter shape, improvement in precision of resonance wave Nagamitsu ADD / DROP actuation etc. can be aimed at.
[0018] [Example 2] Two or more above optical waveguide mold wavelength filters of this invention can be connected [showed / the application for patent No. 32480 / 2000 to] similarly, and can realize a 1xN optical waveguide mold wavelength filter.
[0019] Drawing 5 shows an example of the 1x2 optical-waveguide mold wavelength filter at the time of connecting two optical waveguide form wavelength filters. While adjoins and, as for two optical waveguide mold wavelength filters, the through bus (12a) of input-side optical waveguide (1a) and the input bus (11b) of the input-side optical waveguide (1b) of another side are connected. The ring resonator in the optical waveguide mold wavelength filter (1a) which is connected and adjoins by which the laminating was carried out as mentioned above (3aa) (3ab) The resonant wavelength of the laminating ring resonator (3ba) (3bb) in an optical waveguide mold wavelength filter (1b) differs from (it is hereafter called a laminating ring resonator) mutually, and a 1x2 optical-waveguide mold wavelength filter is constituted.
[0020] in this case, the wavelength multiplexing lightwave signal lambda 1 by which incidence was carried out from the input bus (11a) of the input-side optical waveguide (1a) of one optical waveguide mold wavelength filter ... N Wavelength lambdaa which is in agreement with the resonant wavelength of a laminating ring resonator (3aa) (3ab) or a laminating ring resonator (3ba) (3bb) in case input-side optical waveguide (1a) (1b) is spread Or lambdab A lightwave signal It is separated spectrally into the DROP bus (21a) (21b) of output side optical waveguide (2a) (2b) with which the laminating ring resonator (3aa) (3ab) or the laminating ring resonator (3ba) (3bb) has lapped. On the other hand, it is wavelength lambdaa similarly. Light or wavelength lambdab If light is inputted from an ADD bus (22a) (22b), it will be multiplexed by the through bus (12a) (12b) through a laminating ring resonator (3aa) (3ab) or a laminating ring resonator (3ba) (3bb).
[0021] Since this 1x2 optical-waveguide mold wavelength filter should just connect the optical waveguide mold wavelength filter of this invention, it can be made very small. And since the filter shape of each optical waveguide mold wavelength filter (3a) (3b) serves as a cube type as mentioned above, the filter shape of a 1x2 optical-waveguide mold wavelength filter also serves as a cube type.
[0022] Of course, three or more optical waveguide form wavelength filters (3) may be made to connect similarly, and philharmonic 1xN optical waveguide form wavelength who has a good cube type filter shape suitable for wave-length multiple telecommunication can be realized.
[0023] [Example 3] drawing 6 and drawing 7 illustrate the 1xN optical waveguide mold wavelength filter which is one another example of this invention respectively.
[0024] The 1xN optical waveguide mold wavelength filter illustrated to these drawing 6 and drawing 7 has the composition that the DROP bus (21a) of the output side optical waveguide (2a) of an optical waveguide mold wavelength filter located in an endmost part and the input bus (11b) of the input-side optical waveguide (1b) of other adjoining optical waveguide mold wavelength filters were connected. The laminating ring resonator (3aa) (3ab) of the optical waveguide mold wavelength filter of an endmost part location has lapped with the input bus (11a) and the DROP bus (21a) in the example of drawing 6 R> 6, and has lapped with the ADD bus (22a) and the through bus (12a) in the example of drawing 7 .

[0025] With such a 1xN optical waveguide mold wavelength filter of a configuration, if FSR(s) of the resonant wavelength of the laminating ring resonator (3a) (3b) of the optical waveguide mold wavelength filter of an endmost part location and the laminating ring resonator (3a) (3b) of other adjoining optical waveguide mold wavelength filters differ and only one resonance peak wavelength is in agreement, only one peak can be taken out from two or more peaks of a periodic filter shape (the so-called tandem-type property). Moreover, it will become a cube type if each resonant wavelength is shifted merely for a while.
[0026] [Example 4] the optical waveguide mold wavelength filter in each above-mentioned example although it has the composition that the laminating of the laminating ring resonator (3a) (3b) (drawing 5 - drawing 7 -- setting -- or (3(3aa) ab) (3ba)) (3bb) was carried out on the input-side optical waveguide (1) which crossed on the same hierarchy, and output side optical waveguide (2) As illustrated to drawing 8 besides this configuration, the laminating of the laminating ring resonator (3a) (3b) is carried out on input-side optical waveguide (1), and it can also consider as the configuration by which the laminating of the output side optical waveguide (2) was carried out on the upper ring resonator (3b). of course, some laminating ring resonators (3a) (3b) -- input-side optical waveguide (1) and output side optical waveguide (2) -- it has lapped with a certain spacing. Moreover, as for input-side optical waveguide (1) and output side optical waveguide (2), whichever may become up and down.
[0027] In [an example 5] and time, with above optical waveguide mold wavelength filters of this invention or 1xN optical waveguide mold wavelength filters The core layer of each optical waveguide (1) and (2), a cladding layer, or its both It shall become with an ingredient with an ingredient with an ingredient with the electro-optical effect, or a thermooptic effect, or a photoelastic effect. By good making strange resonant wavelength of a laminating ring resonator (3a) (3b) according to control of external electrolysis, control of temperature, or control of external force, an adjustable wavelength filter and an optical switch are realizable.
[0028] Drawing 9 , drawing 10 , and drawing 11 are the important section block diagrams having shown one example of this adjustable wavelength filter respectively. In each example, the core layer of input-side optical waveguide (1) and output side optical waveguide (2), a cladding layer, or its both have become with the ingredient with an ingredient with an ingredient with the electro-optical effect, or a thermooptic effect, or a photoelastic effect.
[0029] It has a heating element (4) as a heat type control means on the upper ring resonator (3b), and the resonant wavelength of a laminating ring resonator (3a) (3b) can be controlled now by the example shown in drawing 9 by this heating element (4). Under the present circumstances, in order to prevent a heating element's (4)'s becoming a cause and the Q value of a laminating ring resonator (3a) (3b) decreasing, it is desirable to prepare the buffer layer of a low refractive index between the upper ring resonator (3b) and a heating element (4). Moreover, you may have the heating element (4) on the cover layers (for example, SiO2 etc.) of a laminating ring resonator (3a) (3b). In this case, a heating element (4) can be made into the ring configuration which did not need to be located in right above [of a laminating ring resonator (3a) (3b)], for example, surrounded the laminating ring resonator (3a) (3b).
[0030] On the other hand, since the laminating ring resonator (3a) (3b) has the property of high sensitivity, the resonance frequency can be adjusted by having a metal board or a dielectric sheet metal object on the upper ring resonator (3b).
[0031] With the adjustable wavelength filter illustrated to drawing 10 The upper ring resonator (3b) upper part is equipped with the machine optical control means (5) which has glass or the sheet metal object made from a polymer (52) held with a micro electronic mechanical-cable-type (MEM) piston (51) and this MEM piston (51). By a sheet metal object's (52)'s moving up and down in the upper ring resonator (3b) upper part according to the piston action of an MEM piston (51), and controlling spacing between the ring resonators (3b) and sheet metal objects (52) which change by this The resonance frequency of a laminating ring resonator (3a) (3b) is controlled.
[0032] As for a sheet metal object (52), it is desirable that it is in the condition of having covered all the front faces of a laminating ring resonator (3b) so that a laminating ring resonator (3a) (3b) may be disturbed by the ununiformity and reflection may not arise.
[0033] Moreover, when the thing made from a polymer is used as a sheet metal object (52), the sheet

metal object made from a polymer (52) and the upper ring resonator (3b) can be made into the condition of having always touched, and the refractive index of the sheet metal object made from a polymer (52) can be made lower than the refractive index of a laminating ring resonator (3a) (3b) by this. And according to the photoelastic effect of the polymer from which a refractive index changes, the resonant wavelength of a laminating ring resonator (3a) (3b) is controllable by the pressure pressurizing this sheet metal object made from a polymer (52).

[0034] As for the adjustable wavelength filter illustrated to drawing 11 , resonant wavelength of a laminating ring resonator (3a) (3b) is electrically made adjustable for a refractive index by the strange good electro-optics component (6). The electro-optics component (6) as this electro-optics type control means becomes with matter, such as an electro-optics polymer electrically controlled by the electrical potential difference impressed through an electrode (61), and it has this on the upper ring resonator (3b).

[0035] In addition, although each above-mentioned example in this example 3 is the case of an adjustable wavelength filter, an optical waveguide mold optical switch is also realizable by adjusting the phase of a laminating ring resonator (3a) (3b) etc. similarly.

[0036] This invention is not limited to the above example and various modes are possible for it about details. Although each example mentioned above is a thing in case the number of the ring resonators by which the laminating was carried out is two, of course, the laminating of the ring resonator beyond it may be carried out, and if the number of laminatings of a ring resonator increases, the surface smoothness of a transparency band will improve indeed. Even if n ring resonators are the optical waveguide mold wavelength filters by which the laminating was carried out, of course, a 1xN optical waveguide mold wavelength filter, an adjustable wavelength filter, and an optical switch are realizable.

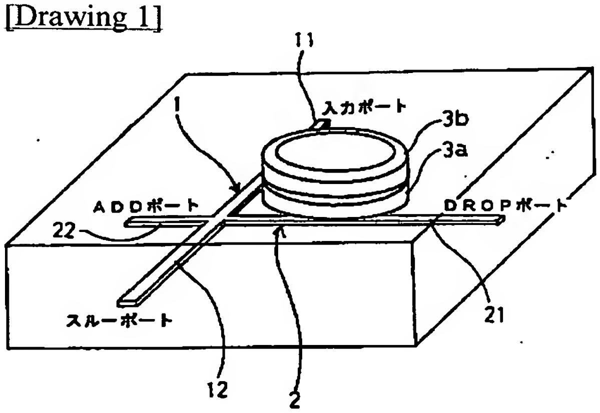
[0037]

[Effect of the Invention] It is small and the adjustable wavelength filter and optical switch constituted with the new optical waveguide mold wavelength filter which has the outstanding cube type filter shape, the 1this optical waveguide mold wavelength filter was connected [one] xN optical waveguide mold wavelength filter, and these optical waveguide mold wavelength filter are offered by this invention as explained in detail above. Thereby, the further large-capacity-izing of optical communication and advanced features can be attained now.

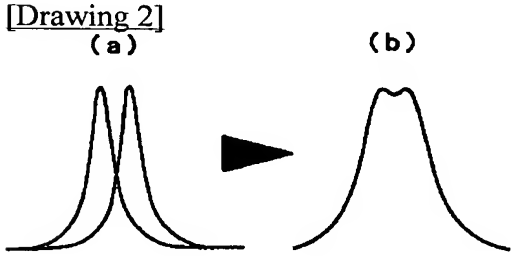
[Translation done.]

DRAWINGS

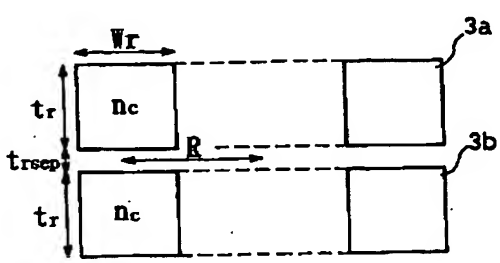
[Drawing 1]



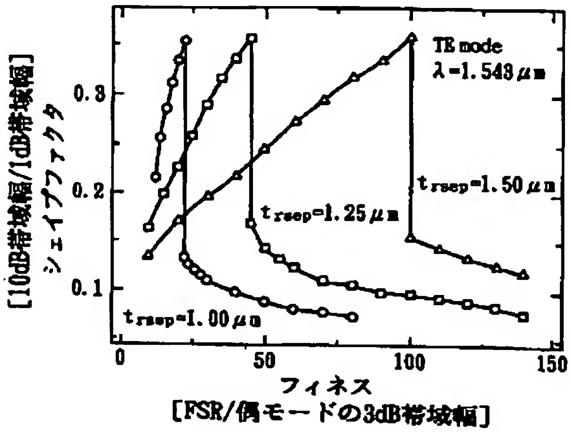
[Drawing 2]



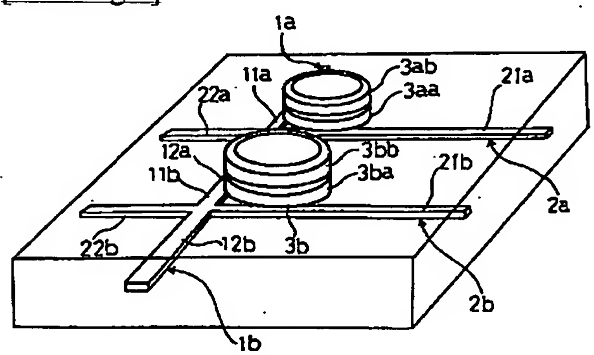
[Drawing 3]



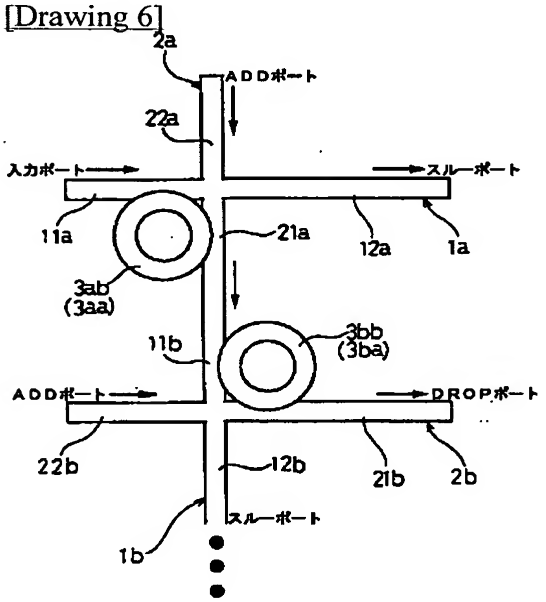
[Drawing 4]



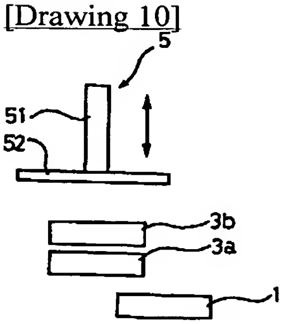
[Drawing 5]



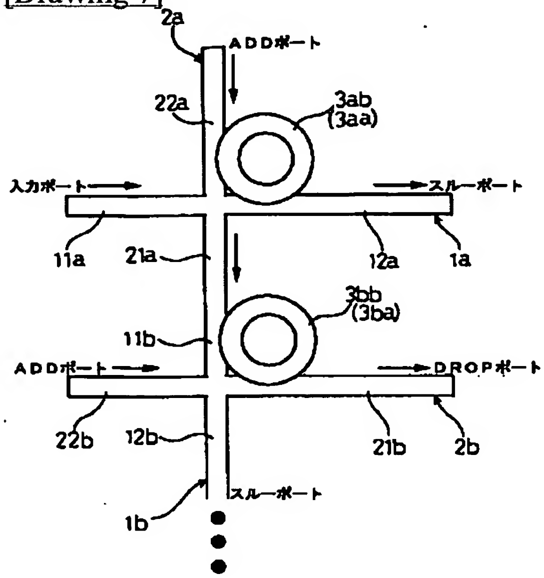
[Drawing 6]



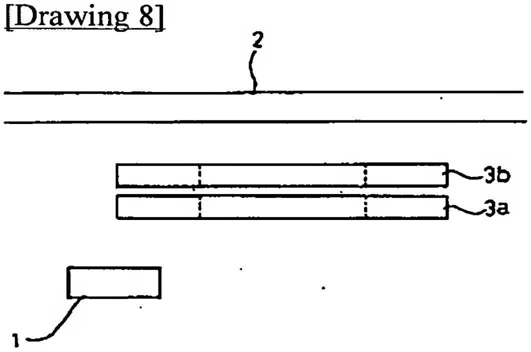
[Drawing 10]



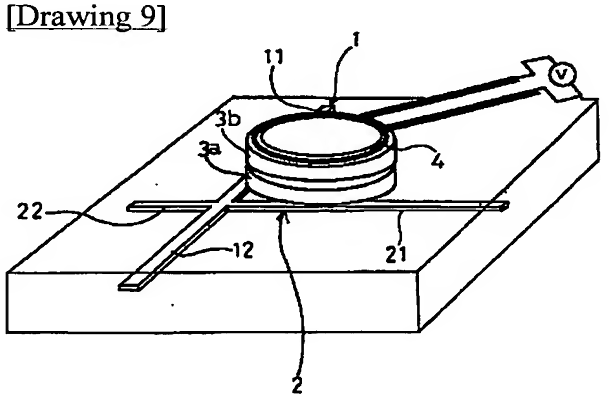
[Drawing 7]



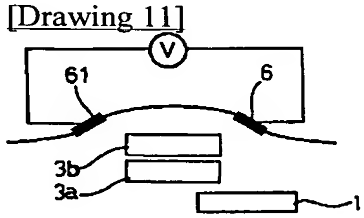
[Drawing 8]



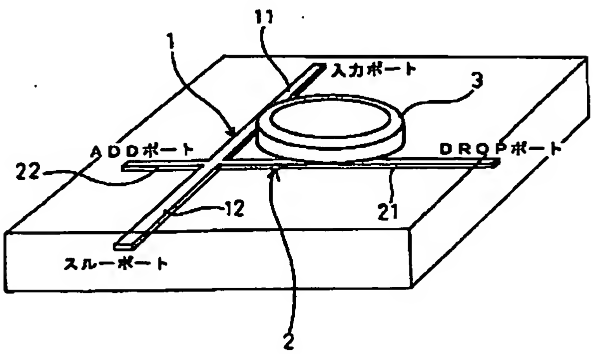
[Drawing 9]



[Drawing 11]



[Drawing 12]



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